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RESULTS OF INVESTIGATIONS OF SOME BIO -MORPHOLOGICAL TRAITS OF VIRGINIA TOBACCO VARIETIES AND LINES IN THE PRODUCING REGION OF PRILEP IN 2010 AND 2011

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ABSTRACT

Investigation was carried out in 2010 and 2011 with 7 Virginia varieties and male sterile hybrid varieties and lines in the region of Prilep. American fertile variety K-326 was used as a check. The following traits were analyzed during the growing season: time of flowering, length and width of the 5th , 10th and 15th leaf, stalk height and number of leaves. In most of these traits the male sterile hybrids proved to be superior to the fertile genotypes, with small advantage of the hybrid V-88/09 CMS F_1. The obtained results can help the producers to make decision which genotype to use in the start of the production cycle.

Keywords: tobacco, variety, Virginia tobacco, flowering, leaves, stalks, dimensions

РЕЗУЛТАТИ ОД ИСТРАЖУВАЊАТА НА НЕКОИ БИО-МОРФОЛОШКИ СВОЈСТВА КАЈ ВИРЏИНИСКИ СОРТИ И ЛИНИИ ТУТУНИ ВО ПРИЛЕПСКИОТ ПРОИЗВОДЕН РЕОН ВО 2010 И 2011 ГОДИНА

Во трудот презентирани се резултати од истражувањата со 7 вирџиниски сорти и машкостерилни хибридни линии во реонот на Прилеп, во 2010 и во 2011 година. Како контролна сорта беше користена американската фертилна сорта К-326. Во текот на вегетацијата беа анализирани: времето на цветање, должината и ширината на 5 ^{от}, 10 ^{от} и 15 ^{от} лист, висината на стракот и бројот на листовите. Во повеќето од овие својства машкостерилните хибриди се покажале како посупериорни од фертилните генотипови, со извесна предност на хибридот V-88/09 ЦМС F_1. Овие резултати можат да придонесат при одлуката на произведителот со кој генотип ќе стартува во производниот циклус.

Клучни зборови: Тутун, сорта, вирџинија, цветање, листови, стракови, димензии.

INTRODUCTION

Presently, Virginia tobacco raw is inevitable component of modern cigarette types and it participates with different percentages in cigarette mixtures. To obtain a good quality raw material, two basic requirements should be met: good variety and strictly controlled production typical of the type. Macedonian fabrication has a need for Virginia tobacco, which is 100% imported. Up to 2002, some of the

needs were satisfied by domestic production. According to (Risteski, 2000), Virginia tobacco production in R. Macedonia reached 1633 tons in the period 1976 - 1988 and 1475 tons in 1989-1997. In 2002 the production of this type ceased and this situation has remained unchanged until today. For successful restart, in our opinion, it would be necessary to use cheaper energy sources for curing (gas, gas-solar energy combination, cheap solid fuels), to introduce new, highly productive varieties and to distribute them most properly by the regions. All this will lower the price of the raw material, making it more competitive on the market.

Scientific Tobacco Institute in Prilep has been working successfully on creation of Virginia varieties with high economic value, which would be a guarantee for a successful restart of production of this tobacco. This statement is based on the results of comparative investigations with varieties from other countries known for production of this tobacco type. A part of these investigations will be presented in this paper.

MATERIAL AND METHOD

The two-years investigation (2010 2011) was carried out with 7 varieties, three of which were fertile (K - 326 from USA, Virginia SKR from Zimbabwe and V- 972 from Germany) and four male sterile hybrids (V-88/09 CMS F_1, V-63/04 CMS F_1, V-78/07 CMS F_1, V-82/07 CMS F_1), all of them created in Tobacco Institute – Prilep.

The American variety K - 326 was used as a check. The trial was set up in the field of Tobacco Institute on colluvial soil. The first ploughing was done at a depth of 40 cm. In spring, the plots were fertilized with 300 kg/ha NPK (8:22:20) and then ploughed two times more. Before transplanting, the plots were treated with selective herbicide and healthy seedlings were planted in randomized block design with 4 replications at 90 × 50 cm planting density.

Prior to second hoeing, 3 g / 26 % KAN was applied for nutrition of the plants. In the period of extended drought and in development stages when tobacco requirements for water were higher, additional irrigations were made. The plants were also treated with chemicals for their protection from pests and diseases. During the growing season, time of flowering was recorded and morphological measurements were made on 5 stalks of each variety. Analysis was made on the 5th, 10th and 15th leaf on the stalk, i.e. the belt which accounts for 60-70 % of the total leaf mass. According to (Uzunoski, 1983) these leaves are the largest in size (over 35 cm) and they are ranked in the I class. These leaves were also measured for their width. Each variety was analyzed for height of the stalk with inflorescence and total number of leaves per stalk. The obtained results were statistically processed using the method analysis of variance and tested with LSD test.

RESULTS AND DISCUSSION

- Length of the growing season (flowering)

This biological trait is considered as varietal characteristic, lasting in the period from planting to the end of flowering. (Rubin, 1971) reported that the first flower is the central (top) flower and the other bloom continuously within 10 to 15 days. According to (Hawks et al.,1994), tobacco varieties which bloom later usually have a higher number of leaves. Results on investigation of this trait are presented in Table 1.

Table 1. Length of the growing season (flowering)

Variety	Year	Beginning of flowering, in days	2010/2011 Average	Absolute differences from the average	50% flowering, in days	2010/2011 Average	Absolute differences from the average	End of flowering, in days	2010/2011 Average	Absolute differences from the average
K-326	2010	58	60.0	/	63	65.5	/	69	71.5	/
	2011	62			68			74		
Virginia SKR	2010	59	61.5	+1.5	65	67.0	+1.5	71	73.0	+1.5
	2011	64			69			75		
V-972	2010	60	62.0	+2.0	64	67.5	+2.0	70	73.0	+1.5
	2011	64			71			76		
V-88/09 CMS F_1	2010	63	66.5	+6.5	71	73.5	+8.0	77	79.0	+7.5
	2011	70			76			81		
V-63/04 CMS F_1	2010	61	62.5	+2.5	67	68.5	+3.0	73	74.5	+3.0
	2011	64			70			76		
V-78/07 CMS F_1	2010	62	65.5	+5.5	68	71.0	+5.5	73	77.0	+5.5
	2011	69			74			81		
V-82/07 CMS F_1	2010	64	66.5	+6.5	69	72.5	+7.0	75	79.0	+7.5
	2011	69			76			83		

From data in Table 1 it can be seen that earliest flowering was observed in varieties K - 326 (check) and Virginia SKR (60 and 61.5 days, respectively). Latest flowering was recorded in hybrids V-88/09 CMS F_1 and V-82/07 CMS F_1 (66.5 days, or 6.5 days longer compared to the check variety. In other varieties and lines, this parameter ranged from 62 days in variety V- 972 to 65.5 days in hybrid V-78/07 CMS F_1. Also, 50 % flowering was achieved first by varieties K - 326 and Virginia SKR (in about 65.5 and 67 days, respectively). Longest period to achieve this stage was observed in hybrid V-88/09 CMS F_1 (73.5 days, or 8 days longer than the check). In

other varieties and hybrids, this parameter ranges between 67 days in variety Virginia SKR and 72.5 days in hybrid V-82/07 CMS F_1. According to (Naumoski et al., 1977), by the end of flowering almost 90 % of the total leaf mass has already been formed on the stalk. This period is shortest in the check variety K - 326 (71.5 days) and longest in hybrids V-88/09 CMS F_1 and V-82/07 CMS F_1 (79 days, or 7.5 days longer than the check variety). In other varieties and hybrids included in this investigation, the end of flowering stage ranges from 73 days in varieties V-972 and Virginia SKR to 77 days in hybrid V-78/07 CMS F_1.

General conclusion for all varieties and lines included in the trial is that male sterile hybrids need a longer period to complete all stages of flowering compared to the fertile varieties.

Length of the 5th, 10th and 15th leaf

Typical representative of leaves that carry the yield and quality of Virginia tobacco is the zone that includes the leaves (from the 5th up to the 15th leaf). Their morphological characteristics are genetically controlled, but they are also affected by the soil and climate conditions and application of various agro-technical measures. In order to be ranked in the I class, these leaves must be longer than 35 cm. According to (Beljo, 1996), the length of tobacco leaves ranges from 10 cm to 80 cm. (Risteski, 1999) reported that leaves of the variety MB-1 from stalks grown at larger nutrition area are longer.

The size of the 5th, 10th and 15thy leaf are presented in Table 2.

Data from the above table reveal that the largest 5th leaf length of 54.6 cm was observed in hybrid V-88/09 CMS F_1, which is 5.9 cm more compared to the check variety K – 326 (48.7 cm). The lowest average length of the 5th leaf (40.7 cm) was observed in variety V- 972. In other varieties and hybrids this parameter ranged from 45.5 cm in hybrid V-63/04 CMS F_1 to 51.8 in hybrid V-82/07 CMS F_1. In 2010, statistically significant differences at 5 % level were recorded only in hybrid V-88/09 CMS F_1. In 2011, statistically significant differences at 5 % level were recorded in the variety Virginia SKR and at a level of 1 % in hybrids V-88/09 CMS F_1 and V-82/07 CMS F_1.

The largest 10th leaf length of 65.5 cm was found in hybrid V-88/09 CMS F_1, which is 10.1 cm more compared to the check variety K-326 (55.4 cm). The length of the 10th leaf was the lowest in variety V- 972 (52.0 cm).

In other varieties included in the trial, this parameter ranged from 60.3 cm in Virginia SKR to 63.0 cm in hybrid V-78/07 CMS F_1.

Statistically significant differences at 5 % level were recorded only in 2010 in the variety Virginia SKR. Significance level of 1% was observed in all male sterile varieties in both years of investigation and only in 2011 such level was found in the variety Virginia SKR.

The largest 15th leaf length of 59.7 cm was recorded in the hybrid V -88/09 CMS F1, which is 6.2 cm more compared to the check variety K-326 (53.5 cm). In other varieties, the average length of the 15th leaf ranges from 48.0 cm in V- 972 to 59.5 cm in hybrid V-78/07 CMS F1.

Statistically significant difference of 5% was recorded only in 2010 in variety Virginia SKR, hybrids V-82/07 CMS F1 and V 88/09 CMS F1. Significant difference at 1% level in both years of investigation was recorded in hybrid

V 78/07 CMS F1 and only in 2011 it was found in hybrids V-82/07 CMS F1, V-63/04 CMS F1 and V-88/09 CMS F1.

Table 2. Length of the 5th, 10th and 15th leaf

Variety	Year	Length of the 5th leaf			Length of the 10th leaf			Length of the 15th leaf		
		in cm	average 2010/2011	difference in cm	in cm	average 2010/2011	difference in cm	in cm	average 2010/2011	difference in cm
K-326	2010	49.0	48.7	/	57.7	55.4	/	55.5	53.5	/
	2011	48.4			53.2			51.6		
Virginia SKR	2010	52.8	51.5	+2.8	61.5^{+}	60.3	+4.9	59.2^{+}	56.5	+3.0
	2011	50.2^{+}			59.2^{++}			53.8		
V-972	2010	41.4	40.7	-8.0	53.2	52.0	-3.4	48.6	48.0	-5.5
	2011	40.0			50.8			47.4		
V-88/09 CMS F_1	2010	54.8^{+}	54.6	+5.9	67.0^{++}	65.5	+10.1	60.0^{++}	59.7	+6.2
	2011	54.4^{++}			64.0^{++}			59.4^{++}		
V-63/04 CMS F_1	2010	46.0	45.5	-3.2	62.8^{++}	61.1	+5.7	58.2	56.8	+3.3
	2011	45.0			59.4^{++}			55.4^{++}		
V-78/07 CMS F_1	2010	50.4	50.4	+1.7	63.6^{++}	63.0	+7.6	60.8^{++}	59.5	+6.0
	2011	50.4			62.4^{++}			58.2^{++}		
V-82/07 CMS F_1	2010	51.6	51.8	+3.1	63.8^{++}	62.4	+7.0	59.2^{+}	57.7	+4.2
	2011	52.0^{++}			61.0^{++}			56.2^{++}		

	Length of the 5th leaf		Length of the 10th leaf		Length of the 15th leaf	
	2010	2011	2010	2011	2010	2011
LSD	5% $^{+}$ = 4.57 cm	2.34 cm	5% $^{+}$ = 3.43 cm	2.86 cm	5% $^{+}$ = 3.67 cm	2.23 cm
	1% $^{++}$ = 6.77 cm	3.21 cm	1% $^{++}$ = 4.70 cm	3.93 cm	1% $^{++}$ = 5.03 cm	3.06 cm

From the above data it can be concluded that the 10th leaf has the largest length in all varieties and hybrids included in the trial.

Width of the 5th , 10th and 15th leaf

Width of the leaf, just as its length, is genetically controlled trait and varietal characteristic, but it is also influenced by soil and climate condition s and the applied agrotechniques. The best length and width ratio is 2:1.

Kalamanda (2009), in her investigations in Republika Srpska with varieties DH- 17 and Hewessi - 17, found that width of the leaves from the middle insertion ranged from 19.40 cm in Hewessi - 17 in 2004 to 25.40 cm in DH- 17 in 2006. (Devcic et al.,1982) reported an average leaf width ranging from 21 cm in varieties H- 30 and

H- 31 to 20 cm in H- 32. The data obtained for this parameter are presented in Table 3.

Table 3. Width of the 5th , 10th and 15th leaf

Variety	Year	Width of the 5th leaf			Width of the 10th leaf			Width of the 15th leaf		
		in cm	Average 2010/2011	Difference in cm	in cm	Average 2010/2011	Difference in cm	in cm	Average 2010/2011	Difference in cm
K-326	2010	29.7	30.1	/	33.3	32.5	/	30.5	29.4	/
	2011	30.6			31.8			28.4		
Virginia SKR	2010	32.5	31.8	+1.7	31.6	30.9	-1.6	30.5	29.9	+0.5
	2011	31.2			30.2			29.4		
V-972	2010	28.2	27.9	-2.2	39.4^{++}	38.0	+5.5	26.2	26.5	-2.9
	2011	27.6			36.6^{++}			26.8		
V-88/09 CMS F $_1$	2010	33.8^{+}	33.6	+3.5	41.8^{++}	41.4	+8.9	31.4	30.2	+0.8
	2011	33.4^{+}			41.0^{++}			29.0		
V-63/04 CMS F $_1$	2010	31.6	31.1	+1.0	37.2^{+}	35.9	+3.4	32.2	30.8	+1.4
	2011	30.6			34.6^{+}			29.4		
V-78/07 CMS F $_1$	2010	33.2	32.2	+2.0	39.2^{++}	38.6	+6.1	30.6	29.4	/
	2011	31.0			38.0^{++}			28.2		
V-82/07 CMS F $_1$	2010	34.6^{+}	34.2	+4.1	38.6^{++}	37.5	+5.0	30.0	29.3	-0.1
	2011	33.8^{++}			36.4^{++}			28.6		

	Width of the 5th leaf		Width of the 10th leaf		Width of the 15th lea	
	2010	2011	2010	2011	2010	2011
LSD	5% $^{+}$ = 3.75 cm	2.34 cm	5% $^{+}$ = 3.59 cm	2.33 cm	5% $^{+}$ = 2.53 cm	1.89 cm N.S.
	1% $^{++}$ = 5.19 cm	3.21 cm	1% $^{++}$ = 4.92 cm	3.20 cm	1% $^{++}$ = 3.47 cm	2.59 cm N.S.

According to the data in the table, the largest average width of the 5th leaf (34.2 cm) was found in hybrid V-82/07 CMS F_1 and it is 4.1 cm more compared to the check variety K – 326 (30.1 cm). The lowest average width (27.9 cm) was recorded in the variety V- 972. In other varieties and hybrids, the average width ranges between 31.1 cm in hybrid V-63/04 CMS F_1 and 33.6 cm in hybrid V-88/09 CMS F_1. Statistically significant differences at 5 % level in relation to the check were recorded in hybrid V-88/09 CMS F_1 in 2010 and 2011, and in hybrid V-82/07 CMS F_1 in 2010. In the latter, statistically significant difference at 1 % level was recorded in 2011.

The largest average width of the 10th leaf (41.4 cm) was recorded in hybrid V-88/09 CMS F_1 and it is 8.9 cm more compared to the check variety K – 326 (32.5 cm). The largest average width of the leaf measured in variety Virginia SKR was 30.9 cm. In other varieties included in the experiment the average width ranged from

35.9 cm in hybrid V-63/04 CMS F_1 to 38.6 cm in hybrid V-78/07 CMS F_1. Statistically significant differences at 5 % level in both years of investigation were recorded in hybrid V-63/04 CMS F1. Significant difference at 1 % level was recorded in variety V- 972 and hybrids V-88/09 CMS F1, V-78/07 CMS F1 and V-82/07 CMS F_1. The largest average width of the 15th leaf (30.8 cm) was recorded in hybrid V-63/04 CMS F_1, which is 1.4 cm more than that of the check K - 326 (29.4 cm). The lowest average width of 26.5 cm was found in variety V- 972. In other varieties, the average width ranged between 29.3 cm and 30.2 cm. No statistically significant differences among varieties and hybrids in both years of investigation were recorded for this trait.

Height of the stalk with inflorescence and Number of leaves

According to Uzunoski (1985), morphological properties of tobacco are highly variable under the influence of environmental conditions and agrotechnical practices. Thus, height of the stalk varies from 25cm to 300 cm and over. These variations are also genetically controlled, i.e. they depend on the type or variety of tobacco. The same author (1983), in his investigations on Virginia tobacco in the region of Kicevo, reported that stalk height in the Italian variety S – 7, depending on the locality, ranged between 215 and 300 cm. According to (Devcic et al.,1982), the average stalk height in Croatian varieties H-10, H-31 and H-32 is 170 cm. (Risteski, 1999) reported that height of the stalks in variety MV - 1 is bigger in varieties which are grown on smaller nutrition area. Data on stalk height and leaf number are presented in Table 4.

According to these data, the lowest average height of 197 cm was observed in variety Virginia SKR and it is 27 cm higher than the check variety K - 326 (172 cm). The minimum height of 168 cm was obtained in variety V- 972. In other hybrids, the stalk height varies in the range from 182 to 186 cm. The difference between the highest and the lowest variety is 31 cm. Statistically significant differences compared to the control at 5 % level were observed in hybrid V-78/07 CMS F_1 in 2010 and 2011 and hybrid V-82/07 CMS F_1 in 2011. Significance level of 1 % in the two years of investigation were recorded in variety Virginia SKR and hybrids V-88/09 CMS F_1 and V-63/04 CMS F_1. In hybrid V-82/07 CMS F_1 such difference was observed only in 2010.

Number of leaves per stalk is also genetically controlled trait that is closely related to agroecological conditions, tobacco type, cultural practices etc. Hawks et al. (1994) came to a conclusion that in most of the cases the varieties with higher stalks also have a higher leaf number. This was particularly evident in varieties with mammoth traits which "do not blossom".

(Drazic et al., 2011) reported that the number of leaves in 13 varieties and lines investigated in locality Nova Pazova (Serbia) ranged from 22 to 26.

The results of our investigations (Table 4) show that the highest leaf number was obtained in hybrid V-88/09 CMS F_1 (33.3) and the lowest in check variety (28.8). In other varieties and hybrids in the trial the leaf number ranged from 29.0 to 30.4. The difference between the highest and the lowest leaf number (33.3 vs. 28.8) is 4.5 and it can significantly affect the total tobacco yield. Statistically significant differences compared to the check variety at 5 % level were obtained in Virginia SKR in 2010 and in hybrids V-63/04 CMS F_1 and V-78/07 CMS F_1 in 2011. Significant differences at 1 % level in both years of investigation were

observed only in hybrid V-88/09 CMS F_1, while in 2011 such difference was registered in variety Virginia SKR and hybrid V-82/07 CMS F_1.

Table 4. Height of the stalk with inflorescence and Leaf number

Variety	Year	Stalk height with inflorescence	Average 2010/2011	Differences in cm	Rank	Leaf number	Average 2010/2011	Differences in the average	Rank
K-326	2010	173	172	/	6	29.8	28.8	/	7
	2011	172				27.8			
Virginia SKR	2010	201^{++}	197	+27	1	31.0^{+}	30.4	+1.6	2
	2011	193^{++}				29.8^{++}			
V-972	2010	168	168	-4	7	28.8	29.0	+0.2	6
	2011	168				29.2			
V-88/09 CMSF $_1$	2010	188^{++}	186	+14	2	33.6^{++}	33.3	+4.5	1
	2011	184^{++}				33.0^{++}			
V-63/04 CMS F $_1$	2010	186^{++}	185	+13	3	30.2	29.9	+1.1	5
	2011	184^{++}				29.6^{++}			
V-78/07 CMS F $_1$	2010	183^{+}	182	+10	5	30.6	30.1	+1.3	4
	2011	181^{+}				29.6^{++}			
V-82/07 CMS F $_1$	2010	187^{++}	183	+11	4	30.0	30.3	+1.5	3
	2011	179^{+}				30.6^{++}			

	Stalk height	2010	2011		Leaf number	2010	2011
LSD	5% $^{+}$ =	7.80	6.80		5% $^{+}$ =	1.11	1.44
	1% $^{++}$ =	10.70	9.28		1% $^{++}$ =	1.52	1.99

CONCLUSIONS

- The check variety K - 326 is the first one to begin with flowering (in 60 days) and the first to end (71.5 days). Hybrids V-88/09 CMS F_1 and V-82/09 CMS were the last to begin to flower (66.5 days) and the last to end (79.0 days).

- The largest length of the 5th, 10th and 15th leaf (54.6 cm, 65.5 cm and 59.7 cm, respectively) was observed in hybrid V-88/09 CMS F_1. The smallest length of the 5th, 10th and 15th leaf (40.7 cm, 52.0 cm and 48.0 cm) was recorded in variety V-972.

- The largest width of the 5th leaf (34.2 cm) was measured in hybrid V-82/07 CMS F_1 and the lowest (27.9 cm) in variety V- 972.

- The largest width of the 10th leaf was recorded in hybrid V-88/09 CMS F_1 (41.4 cm) and the lowest in Virginia SKR (30.9 cm).

- The largest width of the 15th leaf (30.8 cm) was observed in hybrid V-63/04 CMS F_1 and the lowest (26.5 cm) in variety V- 972.

- Stalk height with inflorescence is the largest in variety Virginia SKR (197 cm) and the lowest (168 cm) in variety V- 972.

- The highest number of leaves (33.3) was obtained in hybrid V-88/09 CMS F_1 and the lowest (28.8) in the check variety K – 326.

- Male sterile hybrids are dominant in most of the analyzed traits, with some advantage of hybrid V-88/09 CMS F_1.

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